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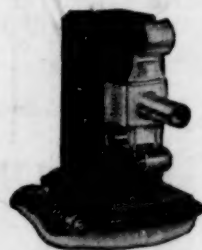
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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE APPLICATION OF SCIENCE TO THE PRACTICE OF MEDICINE*

THE practice of medicine is generally described by that time-worn phrase as being an art and a science. This definition infers that although the practice of medicine is an applied science, there is something beyond the realm of science that is needed in the discharge of the functions of the physician in his relation to his patients. Every one is ready to concede that this is true, but there is no clearly defined idea as to where science leaves off and where art begins, nor have the terms science and art as applied to medical practice received an exact definition.

Professor John Dewey¹ has written:

Just in the degree in which a physician is an artist in his work he uses his science, no matter how extensive and accurate, to furnish him with tools of inquiry into the individual case, and with methods of forecasting a method of dealing with it. Just in the degree in which, no matter how great his learning, he subordinates the individual case to some classification of diseases and some generic rule of treatment, he sinks to the level of the routine mechanic. His intelligence and his action become rigid, dogmatic, instead of free and flexible.

Professor Dewey presents the idea that it is the accurate and discerning application of science to meet the needs of the individual patient that constitutes the art of medicine.

There seems to be, however, another meaning to the phrase "art of medicine," which is associated with the so-called force of personality, knowledge of human nature and prestige by which a physician is often able to persuade or command or influence or even mislead a patient into a better state of health and comfort. The enormous following given to "healers" who make no use of the application of science in its usual sense testifies to the fact that human needs may at the present time be satisfied by systems of practice that have no basis in the natural sciences. Every intelligent person, however, recognizes the fact that although science is not related to many of the

* Address of the president and vice-president of Section N—Medical Sciences—American Association for the Advancement of Science, New York, December, 1928.

¹ John Dewey, "Reconstruction in Philosophy," p. 168, New York, 1920.

methods used by physicians and "healers" in alleviating human ills, scientific knowledge should reign supreme in the great problem that forever presents itself to the human race, namely, of making man a more comfortable, a happier and a more efficient being and of waging a continuous battle with disease. If scientific knowledge does not to-day fulfil all that it should in the practice of medicine, where does the fault lie? Is there sufficient exact, well-established and classified knowledge to form a satisfactory basis for medical practice? Is scientific knowledge applicable to the practice of medicine as fully as possible incorporated in medical practice? Are the methods of applying scientific knowledge to the problems of medical practice properly established? It is to a brief consideration of these questions that attention is directed. If an affirmative answer to these questions were justified, then the force of personality in practice, the so-called art of medicine as the term is usually used, could be put aside as a negligible factor in the functions and methods of the physician. If the practitioner of medicine had at his command a sufficiently comprehensive body of facts to meet all the variable complexities that he encounters in dealing with each individual patient and if he also had knowledge of all the methods of applying these facts to meet the great variety of conditions that may come before him, then could he be a great artist in the sense of the word as used by Dewey.

This body of facts would include knowledge not only of the chemical and physical forces operating in the human body necessary to keep it in a state of normal function and equilibrium, but it would include also a knowledge of the various disturbances of these forces that may occur, of the causations of these disturbances and of the means of their prevention or correction. Analysis alone would not fulfil all the requirements, as the physician would need to understand the synthesis of those forces that go to make up the individual man and to maintain him in a condition of strength and well-being.

The breadth of knowledge that is required in order to conduct the practice of medicine in what may be called a truly scientific manner goes beyond that which is now considered the natural sciences. The responsibility of the physician for the care of patients, as stated in the recent report² of the commission on medical education, calls as well for "a keen insight into a large variety of human, psychological, emotional, economic, social and environmental factors, which often determine successful diagnosis, treatment and prevention."

The physician has constantly before him, whether he is conscious of it or not, many problems that defy

analysis into questions that can be answered by existing knowledge. It is of course self-evident that the accumulated results of scientific investigation do not at present and doubtless never will furnish all the knowledge that can be profitably applied in the practice of medicine, and it is not likely that medical practice can ever be reduced strictly to a state of applied science, such as engineering. It would be futile to discuss this question, as it is clear that the more that is known, the more urgent becomes the need for greater knowledge, and the larger are the number of avenues for research that are revealed.

In regard to the second question as to whether existing knowledge, capable of application, is as fully as possible incorporated into medical practice, here again a negative answer may be given without fear of contradiction. But this is a matter more profitable for discussion. It is worth while to consider some of the factors that hinder the proper application of science to medical practice and to note some of the means that tend to promote the application of scientific knowledge to the needs of individuals requiring medical care.

Practice has always lagged behind the available science, and in times gone by medical tradition was so strong, and scholasticism so deeply rooted that medical practice became entirely divorced from even the meager scientific facts that then existed. An example of the attitude of mind which has retarded the progress of medical practice was long ago satirized by Molière when the physician Diafoirus in "The Imaginary Invalid" recommends his physician son by saying: "But what I like most in him is that he blindly follows the opinions of the ancients—in which he takes after his father. Indeed he will not so much as listen to the arguments or hear of the experiments and pretended discoveries of the present century—on the circulation of the blood and like nonsense." This was written over forty years after the publication of William Harvey's immortal work.

Medical practice even to-day, as conducted by the rank and file of the profession, is overloaded with empiricism and with methods that are maintained, especially in therapeutics, by the force of tradition, sometimes in the face of well-established facts that should bring something better in their place. Much of medical practice has been developed by gallant attempts on the part of physicians to meet the needs of suffering humanity by means that have been improvised where science has nothing to offer or where scientific facts and principles have not yet penetrated into the realm of practical medical knowledge.

The life of the successful physician is usually full of activity and in the majority of instances, especially away from the centers of medical progress, practice soon falls into a routine which is not often seriously

² Commission on Medical Education. Third Report, p. 27, October, 1928.

disturbed by innovations. The younger men, fresh from the schools, may resist the plan of practice of their elders, and so bring down upon themselves and upon their schools disfavor. Many succumb to the force of example and precept of their older colleagues. They may soon learn to do without the scientific basis that had been given them more or less thoroughly. In order to prepare students of medicine to resist in after life the force of empiricism and tradition, scientific habits of mind must be firmly driven in. The result of an attempt to do this is often the cry from the profession that medical education has become "too scientific," whatever that may mean. A sympathetic attitude between the investigator in the medical sciences and those whose task it is to apply the results of research to the welfare of the individual patient is desirable and indeed essential. An antagonism, however, may exist on the part of the workers in science because of an apparent lack of appreciation by the physicians of the facts and methods of science, and on the part of the physicians because of a feeling that the results of scientific research are impractical and that scientific workers fail to appreciate the complex and varied problems constantly encountered by the medical practitioner.

This antagonism, however, is being rapidly replaced by mutual respect and collaboration wherever conditions have been set up that favor contact and coordination of clinicians and investigators. A group of workers is developing that belong both to research and to practice, and members of this group are serving as the middle men, so to speak, between science and practice. This group is developing in those universities which have been able to establish their entire medical schools on a true university basis and in those institutes for medical research which have included clinical medicine as a field for their activities. The members of this group, many of whom are well trained in some field of science underlying medicine, are best qualified to evaluate scientific knowledge in its application to practice, and are best prepared to devise methods for its application. The development of what is often called "academic medicine" is of great value both for the progress of practice and for the furtherance of medical knowledge.

It is perhaps beside the point to emphasize the importance of such a group in the teaching of medicine, but it may be said that by combining men who are constantly at work studying the problems of disease in patients with those whose main activities are devoted to the practice of medicine, a strong teaching force may be established. This combination tends also to create a means of easy communication between the laboratory and the bedside.

The most significant aspect, however, of the development of academic medicine in this country is the

creation of conditions which afford opportunities for a truly scientific career in clinical medicine. Human disease presents numerous problems that are complex and extremely varied. These problems are encountered by workers in no other field but that of clinical medicine, and their solution can not be left to workers in other fields. The status of medicine as an independent science has recently been discussed by Cohn,³ who has argued for the acceptance of the idea that medicine deals with unique phenomena and that it is entitled, not by courtesy, but by the nature of things, to its high status as an independent natural science. Human disease may be studied and should be studied as other phenomena of nature. The practical results for the time being need not be the paramount issue, and therapeutics need not be the acknowledged goal.

Cohn has written:

By the term "medicine" I mean the discipline which is engaged in recognizing, in distinguishing and in studying diseases; the subject-matter of medicine is the sum total of human ailments. It is devoted to the study of disease in the living, fostered by whatever means may appropriately be employed. It is not coexistent with any method, such as experimental pathology, but utilizes data so obtained, whether analogical or inferential, for its own purposes. . . . It appears now that medicine is concerned with knowing about disease, a very different thing from making efforts to cure it.

Cohn presents the idea that there is a science of clinical medicine which is not necessarily a part of medical practice. However, nothing will do more to bring scientific thought and method more rapidly and thoroughly into the field of practice than the further development of means and opportunities for the pursuit of research in human disease directly by those trained to observe the patient and to use the various methods that are applicable to the study of man from many angles. There are of course many limitations put upon those who undertake the study of human disease, and these limitations must always be respected. The true spirit of the physician can never be put aside by those who would observe successfully the nature of disease in human beings. Marchand described the true spirit when he wrote:

Seek truth. Discover causes. Learn how they disturb life and how order is reestablished. By science and persuasion preserve men. By science, gentleness and firmness combat death and reduce suffering. Guide, encourage and console in a brotherly and tolerant spirit. This is medicine.

Here is set forth the method and purpose of science as applied to medical practice. But here is com-

³ Alfred E. Cohn, "Medicine and Science," *Journal of Philosophy*, 1928, xxv, 403.

bined with science the spirit of medicine, the force from within, arising from a sympathetic appreciation of the needs of the individual.

Let those who enjoy the thrills of creative thinking and experiment toil without thought as to how the new knowledge that they may reveal will find its place in human application. Let those who choose the field of medical practice make sure that they apply established facts with discernment and wisdom and run not after strange gods and fallacies. And let those who can do so approach the problem of disease in the spirit that has always proved productive in science, of seeing clearly the problem and seeking the truth by any means that may be serviceable to their purpose. But let us be sure that a means is constantly preserved by which whatever is usable in science finds its way, pure and unperverted, directly and swiftly to the needs of the individual man.

The workers who are coming forward to spend their lives in the small and newly tilled field of clinical research have a large share in keeping clear the way by which science finds its application to medical practice. This field needs further cultivation and should have the encouragement and respect of both workers in the natural sciences whose fields are well defined and organized and of the ancient order of physicians to whom is given the task of bringing the results of science to the needs of the individual.

G. CANBY ROBINSON

NEW YORK HOSPITAL-CORNELL MEDICAL
ASSOCIATION,
NEW YORK

A NOTE UPON THE PROBABLE MODE OF EVOLUTION

WHEN in any group of related organisms, such as a family or higher category in the natural system, the genera are plotted to the number of species they contain—provided only the genera be not too few to justify statistical treatment—a curve of characteristic form is obtained.

The fact was first observed by Dr. J. C. Willis in his statistical studies of recent floras and faunas. Mrs. E. M. Reid showed that analysis of Tertiary floras yields the same result. It may be noted, in addition, that the data regarding such groups as Trilobites, extinct since the Palaeozoic, Tetrabranchiate Cephalopods—with the exception of *Nautilus* now extinct—and Brachiopods, of which a considerable number of species still live, when plotted as stated yield additional examples of the same curve. This, then, is a graphic expression of some universal phenomenon in the organic world. Rather, the "hollow curves" of Willis are a class, which, as parabolas in their variety define the paths of projectiles moving

under the influence of gravitation and their initial velocity, record the detail in which this universal process has expressed itself in the particular groups of organisms to which they respectively apply.

Drs. Willis and G. Udny Yule at first identified this enigmatic curve as that of a geometric series. There is much to justify such identification. When, for example, instead of the actual numbers of genera being plotted to their respective numbers of species, the logarithms of the numbers of genera are plotted to the logarithms of the numbers of their species, the hollow curve is transformed, and the curve obtained as a result of the transformation is, throughout a considerable portion of its length, approximately a straight line. Moreover, the earlier and larger numbers in the series from which the curve is directly plotted yield, when each term is divided by that immediately preceding it, a series of quotients approximating $1/2$ more nearly than any other such simple fraction.

The curve obtained, however, by the substitution of logarithms for natural numbers is *not* a straight line. Nor does the one limb of the original curve, or the series of numbers from which it is plotted, more clearly bear the stamp of $1/2^n$ than the other bears that of a series whose common ratio lies near unity. The hollow curve, we may therefore reasonably assume, results from some sort of compounding of a series of geometric series of different common ratio, but all lying between the limits of $1/2$ and 1.

Now the series $1/2^n$ in its successive terms shows, for example, what proportion of a group of individuals tossing pennies for the longest run of heads would eventually be distributed in each class by achievement—how many would throw no head, one or two heads, and so forth, till even the longest probable sequence had been broken. A different ratio would give the distribution similarly of another group in which the chances of making a comparable gain were different.

With these ideas in mind it is clear that if we might know how many groups were playing a game of chance, the number of individuals in each group and the chances of winning upon any one play in each, the authentic curve showing the final distribution of all players by number of successes scored might be constructed very simply. It would be a graph the first ordinate of which would be proportional to the sum of the first terms of a series of geometric progressions of differing common ratio, the second ordinate proportional to the sum of the second terms, and so to the end. It is upon this system that the geometric series to which the hollow curve owes its peculiarities appear to be compounded.

There is one patent indication regarding the hypothetical series, whose nature and relations it must be

the aim of investigation to discover. It is the fact that in their grand total the series based upon $1/2^n$, or an approximation to $1/2^n$, are much greater than those based upon ratios equally closely approaching unity—their limit, since it measures the prospect of success in each trial indefinitely.

A condition in which the greater number of individuals, measured with respect to whatever quality, lies near the mean directs attention to the normal curve.

If now the half of a polygon of normal frequency lying on one side of the mean be divided into a number of parts of known area—four equal parts will do very well—the average ordinate of each part may be determined from the table of the normal curve, and next the abscissa of that ordinate. This abscissa will measure the amount by which the average individual in the fraction to which it pertains exceeds the average of the entire polygon in respect to the character considered. But the general average may be represented by the fraction $1/2$: and the abscissas above, upon being reduced to fractions of the base of the half-polygon and added separately to $1/2$, yield a series of fractions which may be used as common ratios in such a series of geometric series as it has been suggested may, when compounded, give the hollow curve.

When these several series are calculated, their homologous terms added and the graph of the resultant series plotted, the characteristic curve is in fact obtained. Before discussing the biological significance of this discovery two additional points should be considered. First, may either half of a skewed distribution, when treated as above, give a typical hollow curve? Second, granted that it may, do skewed distributions as a matter of fact serve as the mother-polygons of these curves?

The hollow curve in its typical form depends upon the concurrence of two conditions in the mother-polygon from which it is derived. That polygon must have its area lying largely near the mean in order that the series of $1/2^n$, or those approximating it, may leave the impress upon the resultant that they do. It must have, however, a part, not inconsiderable, far removed from the mean, which, distributed in a number of series with the highest common ratios, leads to the formation of the greatly extended "tail" of the curve lying along the axis of X. In a typical skew curve the half lying to one side of the mean has a concentration toward it which would produce the first effect, the other half the dispersion which would produce the second. Neither half has both. The skewness, if any, in the mother-polygon must therefore be relatively little.

While conditions remain constant, all populations in their growth follow some specific "logistic" or pop-

ulation curve. If conditions change, their growth-rates change, but follow as accurately as ever other curves of the logistic series. It is evident from what has gone before that that process which the hollow curve records is also self-regulating, for secular changes in conditions do not change its type. If this train of thought be pursued in the light of the interpretation placed below upon the curve itself, reason may be discovered, it seems, for excluding the skewed distribution from further consideration.

To proceed with the interpretation of the curve of genera plotted to species, it must first be stated that it is the law of organic evolution which it expresses. In detail, it is really a half-curve of normal frequency whose peculiarities of form and derivation appear to have this meaning:

Genera arise actually, or in effect, as monotypes. With regard to their respective abilities to maintain themselves where first established the prime species of genera in any considerable group of organisms have the distribution of variates forming together a half-polygon of normal frequency lying on one side of the mean.

The success of each prime species in multiplying species within its genus is correlated with its own position in the scale of ability. Strong ones are not more variable than weak. But new species produced by those whose place is insecurely held will, up to full half, fail to maintain themselves. Almost half those genera whose prime species were among the weakest will gain no second. Of those of similar weak ancestry which rise to the rank of ditypes, almost half will advance no farther. Of those whose prime species were fitter for survival under existing conditions a smaller proportion will halt at each stage, and genera whose first representatives were fittest will multiply their species freely. It is to their inclusion in the total that the curve of genera plotted to species owes its great extension along the axis of X, where for many successive stages the division of one term by the preceding gives, not $1/2$ as it should if they belonged to the series $1/2^n$, but a fraction much more closely approaching unity.

These are conclusions whose implications are so far reaching that every possible check upon them must be applied. The following suggest themselves.

In a stable environment the successful types are those whose specialization is most complete. But if conditions change, precisely these are the greatest sufferers. This seems a fair conclusion from the data of paleontology. It may be inferred also from the course of events in every political, social or economic revolution.

But conditions in the world are constantly changing; if for no other reason, as a result of the evolutionary process itself, which introduces new species to

form part of the environment of the old. Therefore, with whatever advantage the first representative of a new order may arise, the first species of new genera, springing from it and persisting, in ability to maintain themselves tend to attain as their limit the distribution of a half-curve of normal frequency. This may be called the Law of Like Distribution of Prime Species. Broad as this generalization is, it covers only a special instance or group of instances included under another still more comprehensive, *i.e.*, in a disturbed system every part tends to reach the position where its potential energy is at a minimum. The half-polygon of the law in its limited sense is the mother-polygon of the curve of genera plotted to species.

Again, the earth, the sea and sea-bottom, as intensive study of the distribution of species in or upon them shows, may be considered a fine mosaic of habitats, differing among themselves and severally suited to the needs of vast numbers of species. Of great numbers of new species arising by mutation, single or superimposed, those groups, which upon units of the multi-faceted world upon which they first establish themselves barely succeed in maintaining themselves, will have smaller success in extending their ranges to even one additional facet than like groups which, establishing themselves under like circumstances, are able to maintain themselves with less difficulty.

The situation is in essence the same as has been discussed above, since for any organic type to add to its range unit after unit unlike that it first held, or even like that first one, is a process analogous to adding species to species within a genus. Both are of that type of success which may be attained in successive trials of a series where the chance of a specified event's occurrence is each time the same. The curve of species plotted against the areas they occupy should be, then, and is, of the same type as that with consideration of which this note began. The fact has been established by Dr. Willis in studies upon the distribution of endemic Angiosperms of Ceylon and New Zealand, the endemic orchids of Jamaica, and by other similar tests. It is confirmed further by the distribution of snails of the genus *Partula* in Raiatea according to Garrett's, and by that of the varieties of species of *Partula* in Tahiti, according to Crampton's records.

It is highly improbable that these are exceptional instances. The first ordinate of the curve derived from the normal polygon of mathematical tables by the treatment outlined above is almost exactly 39.0 per cent. of the sum of all the curve's ordinates. Thirty-eight and six tenths per cent. of the genera of angiosperms are monotypes (Willis); 42.2 per cent. of the genera of Chrysomelidae, Cerambycinae, snakes, lizards and bats; 41.2 per cent. of North

American fossil Tetracoralla, trilobites, tetrabranchiate cephalopods and brachiopods. Forty per cent. of endemic Jamaican orchids occur upon unit area, according to Willis's count. Forty and nine tenths per cent. of the varieties of Tahitian *Partulae* collected by Crampton come from single valleys. Thirty-eight and five tenths per cent. of infants dying under one year in Hamburg in 1912 died in their first month; 42.0 per cent. of male infants and 37.6 per cent. of females similarly in Boston, Mass., in the same year (Whipple). But if they be not exceptional, there is the same reason as above for thinking that the species and varieties concerned have with respect to ability, in each group, the distribution of variates in a half-polygon of normal frequency.

The Angiosperms and Orchidaceae are groups so large and old that prime species of their different genera have probably attained the statistical distribution of variates in a half-curve of normal frequency. The species in their different genera in ability tend to resemble their respective prime ancestors. Thus the distribution of ability in either group as a whole is such that the prevailing distribution of species by areas might have been anticipated. With the single genus it is different. In Tahiti and Raiatea *Partula* behaves in a representative way. But there must be flourishing genera of recent growth which have a disproportionate number of strong species. The first ordinate of the curve of species of such genera plotted to their areas should not be so large a fraction of the sum of all ordinates of the curve as is usually the case.

That the success of each prime species in multiplying species within its genus should be correlated with its own position in the scale of ability implies that the causes of variation are to be sought in the action of manifold external influence upon a complex and unstable germplasm, and that trends in variation under the influence of constant conditions resident in the organism or imposed upon it by its surroundings do not occur. Novelties of whatever possible taxonomic grade have a normal frequency distribution about the parental mean. Not the potential distribution of variates, but the actual distribution of survivors, is affected by secular changes in the environment.

It may be urged, of course, that the ability of organisms to maintain themselves is a resultant compounded from the effects of many variables, whose variation is separately directed by internal or external conditions, but without reference in any to the direction taken in others. But for this view an impasse is created by the fact that a single gene may affect the development of several characters, and that geneticists even venture to think that each gene may perhaps affect the development of all the characters of an organism.

The genes in general seem not at any moment to be narrowly limited with respect to changes they may undergo, or limited either with regard to the ultimate source of the influence to which their changes are due. Chance is arbiter in the field of variation, and the normal frequency curve is the type of distribution to which heritable variations in any stock or character tend to conform.

Given heritable variation uncontrolled in direction, natural selection everywhere operative in the intensity indicated and the undisputed effect of inheritance, it follows inevitably that with respect both to the size of their genera, and to the area their species occupy in the world, organisms must be related numerically as we have seen. It must be possible to say that the graph which summarizes the result of organic evolution, and expresses its law, is a curve derivable from the normal curve and one whose ordinates are successively the sums in order of the homologous terms of an infinite series of infinite descending geometric progressions, whose common ratios lie between the limits of $1/2$ and 1.0 .

Infinite in diversity, admirable in simplicity and unity, is the process whose order may be expressed so briefly.

W. H. LONGLEY

GOUCHER COLLEGE

SCIENTIFIC EVENTS

THE GORGAS MEMORIAL INSTITUTE

THE New York *Times* reports that a program for the participation of every Central and South American country with the United States and the Republic of Panama in an effort to place the Americas on a sanitary status comparable to that of the city of Panama and the Canal Zone, which were transferred by Major-General William C. Gorgas from pest holes of disease to one of the most healthful areas in the world, took form at the meeting of the board of directors of the Gorgas Memorial Institute on April 23.

The proffer by Panama of a site and building, formerly intended for a school of medicine at Panama City, but now dedicated as the Gorgas Memorial Laboratory for the study of tropical disease, was approved by the board.

Dr. Franklin H. Martin, president of the institute, pointed out the importance of this research to every great industry doing business around the Caribbean Sea, as well as its humanitarian significance. "If this laboratory in Panama can discover a cure for malaria," Dr. Martin said, "it would mean a saving for industry of millions of dollars, besides a saving of thousands of lives."

Vice-president Curtis was elected a director of the institute. Ex-president Coolidge, whose term as hon-

orary president of the institute automatically expired with his office as president and whose place has been filled by President Hoover, was elected on the institute's advisory council, as was former Vice-president Charles G. Dawes. Florencio Harmodio Arosemena, president of Panama, and Henry L. Doherty, of New York City, were elected to serve with Mr. Coolidge and Mr. Dawes on the council.

Surgeon-General Edward Riggs and Rear-Admiral Edward R. Stitt, both of the United States Navy, were elected to the board of directors.

MEMORIAL TO DR. SALMON

ANNOUNCEMENT is made by George W. Wickersham, honorary chairman, of the establishment of the Thomas William Salmon Memorial to give recognition to the scientific man who makes the greatest contribution of the year in the field of mental medicine. The memorial is in honor of Dr. Thomas W. Salmon, former professor of psychiatry at Columbia University and medical director of the national committee for mental hygiene, who died on August 13, 1927.

The plans of the memorial call for a series of lectures to be given by the person to whom the award is made in various cities of the United States under the auspices of accredited scientific, medical or educational organizations. It is intended to disseminate knowledge of value in the control and prevention of mental and nervous diseases.

The administration of the initial fund of \$100,000 is to be vested in the New York Academy of Medicine. It will be a permanent and endowed establishment with national and international connections. The movement was started by one hundred and fifty leading neurologists and psychiatrists who are associated with leaders in the mental hygiene movement and in psychiatric, social service and nursing fields.

It is said that universities, medical schools, scientific societies and independent workers in this country and abroad are to be surveyed annually in a search for the individual, prominent or obscure, whose original work promises most in the line of relief to the states, municipalities, private organizations and individuals confronting the economic and humane problems incident to the increasing number of people suffering from mental and nervous diseases.

The honorary vice-chairmen of the memorial include General John J. Pershing, Dr. Nicholas Murray Butler, the Rev. Dr. Harry Emerson Fosdick, Mrs. Helen Hartley Jenkins and Dr. John H. Finley. The chairman is Dr. Frankwood E. Williams and the vice-chairman Dr. William L. Russell. Dr. Austen Fox Riggs is secretary; Paul O. Komora, assistant secretary; the New York Trust Company, treasurer, and Dr. Samuel W. Hamilton, assistant treasurer. The

ways and means committee includes Dr. Russell as chairman and Dr. C. C. Burlingame as vice-chairman and the following members: Drs. Stephen P. Duggan, Homer Folks, C. Floyd Haviland, Augustus Knight, Austen Fox Riggs, Frankwood E. Williams and Brigadier-General S. H. Wadhams.

THE MEDALS OF THE FRANKLIN INSTITUTE

THE medal meeting of the Franklin Institute, Philadelphia, will be held on the afternoon of May 15 at 3:30.

Presentations will be made as follows:

Certificate of Merit to Mr. George F. Machlet, American Gas Furnace Company, Elizabeth, New Jersey.

Longstreth Medals to Mr. Edward G. Herbert, Atlas Works, Manchester, England; Dr. Konrad Jagsehtz, Mainz, Germany; Mr. A. W. Machlet, American Gas Furnace Company, Elizabeth, New Jersey, and Mr. J. F. Peters, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Wetherill Medals to Mr. Gustave Fast, The Bartlett Hayward Company, Baltimore, Maryland; Mr. W. H. Mason, Masonite Corporation, Laurel, Mississippi, and Dr. Johannes Ruths, Djursholm, Sweden.

The Levy Medal to Mr. Lodewyk J. R. Holst, Brock and Weymouth, Inc., Philadelphia.

The Clark Medal to Mr. W. H. Gartley, Philadelphia Gas Works Company, Philadelphia.

Cresson Medals to Sir James C. Irvine, St. Andrews, Scotland; Dr. Chevalier Jackson, Jefferson Medical College, Philadelphia, and Dr. Elmer A. Sperry, Sperry Development Company, Brooklyn, New York.

Franklin Medals and Certificates of Honorary Membership to Mr. Emile Berliner, Washington, District of Columbia, and Dr. Charles Thomson Rees Wilson, Cambridge, England, received by Sir Esme Howard, British Ambassador to the United States.

The following papers will be read:

"Vocal Physics—Historical Notes," by Emile Berliner, and "Some Thundercloud Problems," by Professor C. T. R. Wilson, University of Cambridge, who will be presented by Professor John Zeleny, of Yale University.

PRESENTATION OF THE JOHN FRITZ MEDAL TO PRESIDENT HOOVER

PRESIDENT HOOVER received on April 25 the John Fritz Gold Medal, which is annually awarded by the John Fritz Medal Board, representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, for "notable scientific or industrial achievement, without restriction on account of nationality or sex." This medal, which is

the highest honor bestowed by these four engineering societies, with a membership of 60,000, was presented to the President by representatives of the societies, who called at the White House.

According to the report in the *United States Daily*, Dean Dexter S. Kimball, of the College of Engineering, Cornell University, chairman of the present board of award, presided and gave a brief history of the medal. He is a past president of the American Society of Mechanical Engineers. General J. J. Carty, of New York, vice-president of the American Telephone and Telegraph Company, spoke briefly of the human elements of Mr. Hoover's work. Dr. John R. Freeman, past president of the American Society of Civil Engineers and the American Society of Mechanical Engineers and a former member of the board of award spoke of Mr. Hoover's work as an engineer.

J. V. W. Reynders, past president of the American Institute of Mining and Metallurgical Engineers and chairman of the board which made the award to Mr. Hoover, presented the medal and quoted from the certificate which accompanied the medal the citation "To Herbert Hoover, engineer, scholar, organizer of relief to war-stricken peoples, public servant."

The first award of the medal was made to John Fritz at a dinner given to him on his eightieth birthday, August 21, 1902. The other awards have been as follows:

1905, to Lord Kelvin for his work in cable telegraphy and other scientific attainments.

1906, to George Westinghouse for the invention and development of the air brake.

1907, to Alexander Graham Bell for the invention and introduction of the telephone.

1908, to Thomas Alva Edison for the invention of the duplex and quadruplex telegraph, the phonograph, the development of a commercially practical incandescent lamp, the development of a complete system of electric lighting, including dynamos, regulating devices, underground system, protective devices and meters.

1909, to Charles T. Porter for his work in advancing the knowledge of steam engineering and in improvements in engine construction.

1910, to Alfred Noble for notable achievements as a civil engineer.

1911, to Sir William H. White for notable achievements in naval architecture.

1912, to Robert W. Hunt for his contributions to the early development of the Bessemer process.

1913, no award.

1914, to Professor John E. Sweet for his achievements in machine design and pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine.

1915, to Dr. James Douglas for notable achievement in mining, metallurgy, education and industrial welfare.

1916, to Dr. Elihu Thomson for achievement in electrical invention, in electrical engineering and industrial development, and in scientific research.

1917, to Dr. Henry M. Howe for his investigations in metallurgy, especially in the metallography of iron and steel.

1918, to J. Waldo Smith for achievement as engineer in providing the City of New York with a supply of water.

1919, to General George W. Goethals for achievement as builder of the Panama Canal.

1920, to Orville Wright for achievement in the development of the airplane.

1921, to Sir Robert A. Hadfield for the invention of manganese steel.

1922, to Charles Prosper Eugene Schneider for achievement in metallurgy of iron and steel, for the development of modern ordnance, and for notable patriotic contribution to the winning of the great war.

1923, to Senator Guglielmo Marconi for the invention of wireless telegraphy.

1924, to Ambrose Swasey for achievement as designer and manufacturer of instruments and machines of precision, a builder of great telescopes, a benefactor of education, and the founder of Engineering Foundation.

1925, to John Frank Stevens for great achievements as a civil engineer, particularly in planning and organizing for the construction of the Panama Canal; as a builder of railroads, and as administrator of the Chinese Eastern and Siberian Railways.

1926, to Edward Dean Adams for great achievements as engineer, financier, scientist, whose vision, courage and industry made possible the birth at Niagara Falls of hydroelectric power.

1927, to Elmer Ambrose Sperry for the development of the gyrocompass and the application of the gyroscope to the stabilization of ships and aeroplanes.

1928, to John Joseph Carty for pioneer achievement in telephone engineering and in the development of scientific research in the telephone art.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences at its annual meeting held in Washington on April 22, 23 and 24 elected new members as follows: Dr. Roger Adams, professor of organic chemistry at the University of Illinois; Irving W. Bailey, associate professor of botany, Bussey Institution, Harvard University; Dr. A. F. Blakeslee, botanist at the Carnegie Institution's station for experimental evolution at Cold Spring Harbor; Dr. James B. Conant, associate professor of chemistry, Harvard University; Dr. Bergen Davis, professor of physics at Columbia University; Dr. C. J. Davisson, physicist at the Bell Telephone Laboratories, New York; Dr. Joel H. Hildebrand, professor of chemistry at the University of California; William Hovgaard, professor of naval design at the Massa-

chusetts Institute of Technology; Dr. Albert W. Hull, research physicist at the General Electric Company's Research Laboratory at Schenectady; Frank Leverett, geologist of the U. S. Geological Survey and lecturer in glacial geology at the University of Michigan; Dr. Paul W. Merrill, astronomer at the Mt. Wilson Observatory, Pasadena; Dr. David H. Tennent, professor of zoology at Bryn Mawr College; Dr. George H. Whipple, dean of the School of Medicine and Dentistry and professor of pathology at the University of Rochester, N. Y., and Dr. Clark Wissler, curator of ethnology at the American Museum of Natural History, New York, and professor of anthropology in the institute of psychology at Yale University.

FOREIGN associates elected at the Washington meeting of the National Academy of Sciences are: Frederick Orpen Bower, formerly Regius professor of botany at the University of Glasgow; Dr. Richard Hertwig, professor of zoology at Munich; Willem de Sitter, director of the observatory at Leiden, Holland; Dr. Arnold Sommerfeld, professor of physics at Munich, and C. de la Vallée-Poussin, professor of analytical mechanics at Louvain.

At the annual dinner of the National Academy of Sciences the Agassiz medal for oceanography was presented to Dr. J. Stanley Gardiner, professor of zoology and comparative anatomy at the University of Cambridge, and the Watson medal to Dr. Willem de Sitter, director of the observatory at Leiden and professor of theoretical astronomy in the university. The addresses of presentation were made, respectively, by Professor Frank Lillie, of the University of Chicago, and by Professor Ernest W. Brown, of Yale University, and the medals were received by the British ambassador and the Dutch minister.

THE degree of doctor of laws will be conferred on Dr. William S. Thayer, professor emeritus of medicine at the Johns Hopkins University, by McGill University on May 29.

THE Medical College of Virginia will confer the doctorate of science on Dr. Albert Compton Broders, pathologist to the Mayo Clinic, at commencement on May 28. Dr. Broders is an alumnus of the school of medicine of the Medical College of Virginia, Richmond.

THE decoration of grand officer of the Crown of Italy was presented by Count Marchetti, of the Italian Embassy, on April 8 to Dr. William F. Verdi, clinical professor of surgery, Yale University School of Medicine. The speakers included Governor Trumbull, Mayor Tully and President Angell.

THE Research medal of the Research Corporation of New York will be presented on May 10 to Dr. Werner Heisenberg, associate professor of theoretical physics in the University of Leipzig, for "brilliant scientific achievement." Dr. Heisenberg is lecturing at the University of Chicago.

SIR RONALD ROSS, director-general of the Ross Institute and Hospital for Tropical Diseases, has been awarded the Manson medal given triennially by the Royal Society of Tropical Medicine and Hygiene to those of outstanding eminence in the field of tropical medicine and hygiene.

It is reported in *Nature* that the gold medal of the British Institution of Mining and Metallurgy has been awarded conjointly to the Honorable William Lawrence Baillieu and William Sydney Robinson "in recognition of their services in the development of the mineral resources of the Empire, with special reference to the zinc and lead industries of Australia." The medal, in duplicate, will be presented at the annual general meeting of the institution to be held at Burlington House, London, on May 16.

IN celebration of the fiftieth anniversary of the doctor's examination of Professor Raffaello Nasini, of the University of Pisa, funds have been collected for two periodical prizes of 5,000 lire each to be awarded, one in hydrology and one in chemistry.

THE American Pharmaceutical Association has awarded the Remington medal to Dr. Wilbur L. Scoville, chief of the analytic department of Parke, Davis and Company, in acknowledgment of his work as chairman of the National Formulary Committee. Dr. Scoville has served on the National Formulary Committee for three revisions of the formulary, and was a member of the revision committee of the U. S. Pharmacopeia for the 1900 and 1920 revisions. The association in 1922 awarded him the Ebert prize for the most outstanding article presented in its annual meeting.

DR. CHARLES E. CASPARI, dean of the St. Louis College of Pharmacy, was tendered a testimonial dinner on April 4 in commemoration of his twenty-fifth anniversary as professor of chemistry in the college. A picture of Dr. Caspari was presented to the college by the alumni in honor of the occasion. The speakers of the evening represented the college, the alumni, the faculty, the American Pharmaceutical Association and American Association of Colleges of Pharmacy, the City of St. Louis and the industry. Dr. Caspari responded by reviewing the progress of teaching in pharmacy schools during the past twenty-five years.

DEAN VIRGINIA C. GILDERSLEEVE, of Barnard College, Columbia University, has been elected president

of the Association to Aid Scientific Research by Women.

At the recent annual meeting of the American Association of Pathologists and Bacteriologists in Chicago, Dr. George H. Whipple, professor of pathology and dean of the school of medicine and dentistry of the University of Rochester, was made *president*; Major George R. Callender, of the Army Medical School, *president elect*, and Dr. Howard T. Karsner, professor of pathology in the school of medicine of Western Reserve University, *secretary*. The next annual session will be in New York on April 17 and 18, 1930.

As the position of chief of the Weather Bureau is filled by presidential appointment, Professor Charles F. Marvin, who has held this post since 1913, tendered his resignation, in accordance with custom, to President Hoover. Professor Marvin's resignation was returned by President Hoover unaccepted, with the President's assurance that he was anxious that Professor Marvin should continue the distinguished services he had been rendering.

DR. LAUDER W. JONES, of Princeton University, has been appointed associate director for the natural sciences of the Rockefeller Foundation. He will have his headquarters in Paris carrying on the work as successor to Dr. Augustus Trowbridge, now dean of the graduate school of Princeton University.

DR. ALLEN K. KRAUSE, associate professor of medicine and director of Kenneth Dows Tuberculosis Research Laboratory of the Johns Hopkins University, has been selected as director of the Sanitarium and Research Institute near Tucson.

DR. MARK F. BOYD has been appointed director of the division of malaria control of the Mississippi State Board of Health. Dr. Boyd previously was associated with the International Health Board of the Rockefeller Foundation and was director of the station for field studies in malaria at Edenton, N. C.

F. M. RUSSELL, assistant to the Secretary of Agriculture, has submitted his resignation to become vice-president of the National Broadcasting Company, in charge of its affairs in Washington, D. C.

DR. EDWARD HARVEY CUSHING, clinical instructor in medicine in the school of medicine of Western Reserve University, son of the late Professor Henry Platt Cushing, has been appointed a member of the board of the Case Library, Cleveland.

THE first award of the J. T. Baker Chemical Company Analytical Fellowship, Eastern Division, has been made for the academic year 1929-1930 to Mr. Charles H. Greene, who will investigate the solubility

of precipitates in dilute solutions of the precipitant at Harvard University under the direction of Professor G. P. Baxter. Mr. Greene is a graduate of Haverford College, 1926, and received the M.A. degree from Harvard University in 1927.

To carry on work established four years ago and to further the object of relief of famines in China, Professor Harry H. Love, of the department of plant breeding of Cornell University, sailed on March 28. He will establish headquarters at the University of Nanking.

EDWIN W. JAMES, chief of the division of design of the Bureau of Public Roads, whose services have been lent to the government of the Republic of Colombia, South America, at the request of that government, will serve on a commission of five engineers who will endeavor to assist Colombia in improving her entire system of road, rail and water communications.

DR. HERBERT SPENCER DICKEY left on April 25 for the Upper Orinoco Valley as head of an expedition under the auspices of the Museum of the American Indian of the Heye Foundation, to study the tribe of White Indians that is reported to be found there.

DR. HENRY G. KNIGHT, chief of the bureau of chemistry and soils of the U. S. Department of Agriculture, is in the Pacific coast states investigating special agricultural problems in the solution of which the department seeks to aid the farmers of the region.

FRANK REEVES and C. P. Ross, of the U. S. Geological Survey, have returned from two months' work on the Panama Canal Zone, where they examined the proposed Alhajuela dam and reservoir sites for the Panama Canal.

AN Associated Press dispatch reports that W. T. Cox, superintendent of the Upper Mississippi Wild Life and Fish Preserve of the U. S. Biological Survey, is being considered for the post of head of the Forestry Service of Brazil.

PROFESSOR HUGH S. TAYLOR, of Princeton University, left for Germany on April 26. He expects to address the German Bunsen Society at its annual convention, which will be held from May 9 to 12.

DR. P. W. BRIDGMAN, Hollis professor of mathematics and natural philosophy at Harvard University, gave the Guthrie lecture at the Imperial College of Science at South Kensington, London, on April 19. His subject was "The Properties of the Elements under High Pressure."

THE annual Sigma Xi lecture in the University of Iowa was given on April 13 by Professor R. A. Millikan, of the California Institute of Technology, on "Available Energy."

PROFESSOR ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, addressed the Sigma Xi Association at Columbia University at a banquet that was held at the Faculty Club of Columbia on May 2. His topic was "The Romance of Glass."

DR. MAX MASON, director for the natural sciences at the Rockefeller Foundation, will address the Phi Beta Kappa Alumni in New York at the University Club on Thursday evening, May 9. His subject is "Highest Common Factors."

DR. FREDERICK E. WRIGHT, of the Geophysical Laboratory, Washington, D. C., gave a lecture before the Franklin Institute, Philadelphia, on April 11, entitled "The Gravity-Measuring Cruise of the Submarine U. S. S. S-21."

THE deans of the University of Minnesota recommended to the president that Dr. Albert Ernest Jenks, professor of anthropology, represent recent research work of the faculty in an address before the university convocation on April 18. The address given was entitled "Field Researches in the Culture of Prehistoric Americans," and dealt with the field work in Mimbres culture carried on last summer in New Mexico by Dr. Jenks and four graduate students, in cooperation with Mr. Wesley Bradfield, of the Santa Fé Museum. On February 15 the annual Sigma Xi address at the University of Minnesota was delivered on the same subject by Dr. Jenks.

PROFESSOR F. O. BOWER, emeritus professor of botany in the University of Glasgow, gives the Huxley Memorial Lecture at the Imperial College of Science and Technology, London, on May 3. His subject is "The Origin of a Land Flora Reviewed Twenty-one Years after Publication."

DR. JOHN W. HARSHBERGER, professor of botany at the University of Pennsylvania, where he had taught since 1892, died on April 28 at the age of sixty years.

DR. CHARLES E. DE MEDICIS SAJOURS, professor of applied endocrinology in the graduate school of medicine of the University of Pennsylvania, died on April 27. He was seventy-six years of age.

DR. JOHN A. WITHERSPOON, a past president of the American Medical Association and one of the founders of the medical department of Vanderbilt University, died at Nashville on April 25.

DR. S. WATASE, professor emeritus of zoology at the Tokyo Imperial University, died on March 8 at the age of sixty-six years.

THE death is announced of Professor Enrico Morselli, director of the psychiatric clinic of the University of Genoa.

THE seventh annual meeting of the Virginia Academy of Science will be held at the Staunton Military Academy, Staunton, Virginia, on May 10 and 11.

THE building and equipment of the new Chemical Laboratory at Princeton University is now sufficiently advanced that its completion during the coming summer is assured. It is planned to hold the formal opening of the new laboratory on September 26. This will be followed by a two-day conference on the subject of "Catalysis and the Mechanism of Chemical Reactions." Princeton University is inviting on this occasion a number of foreign guests prominent in the field of chemistry to be discussed at the conference and it is expected that their contributions to the discussion will yield an important summary of the present state of knowledge in this field. The details involved in the organization of the conference are in the hands of a committee of the Princeton department of chemistry of which Professor R. N. Pease is the secretary.

FIFTY members of the English Ceramic Society of Stoke-on-Trent have arrived in New York on a three weeks' tour of the United States, the trip being the outcome of an invitation by the American Ceramic Society which visited England last year. It will permit the English ceramists to see at first hand American processes by mass production methods. Many of the earliest potters, craftsmen and designers in the United States came originally from Staffordshire.

FORTY-FIVE geologists from Oklahoma and Texas, under the guidance of members of the staff of the Oklahoma Geological Survey, attended the fifteenth Oklahoma Field Conference, which was held from April 11 to 14 in the Arbuckle Mountains of southern Oklahoma. The civic clubs of Ada tendered the visiting geologists a complimentary dinner, this being the fourth annual dinner so given. The chief object of the conference this year was to study type localities of geological formations, chiefly of lower Paleozoic formations, in the Arbuckles, the greater number of which were first proposed by Taff thirty years ago.

AMHERST COLLEGE has announced plans for its fifteenth geological and mineralogical expedition to the western area of the United States, under the direction of Professor Frederic B. Loomis.

A GEOLOGICAL field study expedition, under the auspices of the Summer Session of Columbia University and the University of Wyoming, will explore some of the highest ranges of the Rocky Mountains from June 17 to July 20. The headquarters will be in Medicine Bow Range, near Laramie, Wyoming, 10,000 feet up, and from this point weekly field trips for detailed

geological observations will be made, at altitudes of 7,000 to 8,000 feet, the territory covered extending from the Continental Divide westward through Laramie Basin. The pre-Cambrian of the Front Range, the great Sherman batholith, 2,000 feet of Paleozoic red beds, the marine and continental deposits of the Mesozoic age as exposed in the Freeze-out Hills and at Como Bluff, the Oligocene of Central Wyoming at Bates's Hole and the precipitous 1,500 foot canyon of the Platte, will be used as the basis of field instruction in structural geology, stratigraphy and physiography. Studies will be made of oil domes, alpine glaciation and the Rocky Mountain peneplane. Professor Roy J. Colony, of Columbia University, and Professor Samuel H. Knight, of the University of Wyoming, will have charge of the expedition, in which many advanced students of geology will take part.

REPRESENTATIVE WM. I. SIROVICH, of New York, has reintroduced his bill to establish and operate a National Institute of Health, authorizing the government to accept donations for use in ascertaining the cause, prevention and cure of disease affecting human beings. He will introduce the bill again next session, if no hearings can be had before the close of this session. Senator Joseph E. Ransdell, of Louisiana, will introduce the bill in the Senate. Representative William B. Bankhead, of Alabama, has introduced a bill authorizing special appropriations for cooperation of the federal government with the states in promoting the health of the rural population of the United States.

UNIVERSITY AND EDUCATIONAL NOTES

THE new building for physics and geology at the University of Tennessee, built at a cost of \$200,000, has been completed and is now ready for occupancy. The chemistry building is nearly completed. Additional buildings which will soon be under way comprise a library, an administrative and a memorial assembly building, which is to be erected jointly by the university, the City of Knoxville and Knox County. It is planned to spend \$2,500,000 in all on the buildings.

THE corner-stone of the John Markle Mining Engineering Hall of Lafayette College will be laid on June 6.

DR. ROBERT MAYNARD HUTCHINS, dean of the law school of Yale University, has been elected president of the University of Chicago to succeed Dr. Max Mason, now director of the division of natural sciences of the Rockefeller Foundation. Dr. Hutchins, who is thirty years old, will assume office on July 1.

At Harvard University, Dr. Arthur Becket Lamb, since 1925 Sheldon Emory professor of chemistry and since 1912 director of the chemical laboratory, in charge of the new Mallinckrodt and Converse Laboratories recently completed, has been elected to the Erving professorship of chemistry in succession to the late Theodore W. Richards. He will be succeeded as Sheldon Emory professor by Dr. James Bryant Conant.

Dr. ERNEST M. HALL, formerly of Stanford University, has been appointed professor of pathology and bacteriology in the school of medicine of the University of Southern California.

Dr. SAMUEL VAN VALKENBURG, professor of geography at Clark University, has accepted appointment to the faculty of the City College of Detroit and will enter upon his new work in the autumn. He went to Clark University in 1927 after five years with the survey department of the Dutch government in Java.

At Lehigh University, Associate Professor Lloyd L. Smail has been promoted to a full professorship of mathematics, and Dr. W. J. Trjitzinsky to an assistant professorship in the same department.

NON-RESIDENT lecturers who will take part in the summer session of Cornell University include Dr. Collier Cobb, professor of geology in the University of North Carolina; Dr. Arthur H. Compton, professor of physics in the University of Chicago, and Dr. P. S. Kupalov, professor of physiology in the Institute of Experimental Medicine, Leningrad.

In German universities, Dr. Paul Krüger, professor of botany at Berlin, has been called to Vienna; Dr. Friedrich Hund professor of theoretical physics at Rostock, has been called to Leipzig, and Dr. Theodor Kaluza, professor of mathematics at Königsberg, has been called to Kiel.

DISCUSSION

THE REPORT OF THE NATIONAL ACADEMY OF SCIENCES ON REAPPORTIONMENT

ALL controversy concerning the mathematical aspects of the problem of reapportionment in Congress should be regarded as closed by the recent authoritative report of the National Academy of Sciences, signed by Professors G. A. Bliss, E. W. Brown, L. P. Eisenhart and Raymond Pearl, and printed in the Congressional Record for March 2, 1929. The National Academy is the body legally appointed to advise Congress on scientific questions, and the report mentioned was prepared at the request of Speaker Longworth of the House of Representatives.

The report lists the following five methods as the only ones that require consideration: "method of smallest divisors, method of the harmonic mean, method of equal proportions, method of major fractions and method of greatest divisors." These five methods are listed in the order in which they "favor the larger states," the first method favoring the larger states the least, and the last method favoring the larger states the most. In particular, the report points out, "the method of the harmonic mean and the method of major fractions are symmetrically situated on the list," so that "mathematically there is no reason for choosing between them"; and the same remark applies to the method of smallest divisors and the method of greatest divisors. (Incidentally, the list of five methods regarded by the academy as the only methods worth considering does not include the "method of minimum range.")

After full consideration of these five methods, the report concludes that the "method of equal proportions" is the method to be preferred, for two reasons: first, "because it satisfies the test [of a desirable apportionment] when applied either to sizes of congressional districts or to numbers of representatives per person"; and secondly, "because it occupies mathematically a neutral position with respect to emphasis on larger and smaller states."

The appearance of this statement from the National Academy which confirms authoritatively the established mathematical theory is particularly timely, since Congress has been in serious danger of being confused and misled by an erroneous theory. (See SCIENCE, December 14, 1928, and March 8, 1929.) The first reason given by the academy for adopting the method of equal proportions completely disproves the erroneous notion that there is some necessary conflict between the test as applied to "sizes of congressional districts" and the test as applied to "numbers of representatives per person," since both forms of the test are satisfied by the method of equal proportions. The second reason given by the academy completely disproves the erroneous notion that the method of equal proportions is unduly favorable to the smaller states, since this method is the one method which "occupies a neutral position" in the list, and does not favor either the larger or the smaller states.

The method which is at present competing with the method of equal proportions is the method of major fractions which was devised by Professor Willcox in 1910 and used in the apportionment for that year, more than a decade before the clarifying modern mathematical theory of the problem became available. The hold which this now obsolete method still maintains on the imaginations of many congressmen is due

mainly, it appears, to a misconception of the meaning of the term "major fractions." The simple ideas which are associated with the name major fractions are hold-overs from the Vinton method, with which Congress was familiar from 1850 to 1900, or from the primitive scheme proposed by Daniel Webster in 1832, and do not apply at all to the much more complicated process now known as the method of major fractions.

It has been contended that when it comes to an actual vote in Congress, the method of major fractions has a "marked advantage" over the method of equal proportions, not because it gives a fairer or more equitable apportionment—which it does not do—but because Congress likes to have before it, as "on every previous occasion," a "table," containing a "constant divisor" and a "series of quotients" in which "each fraction larger than one half" gives an additional member. (SCIENCE, February 8, 1929.)

Why should Congress be so attached to a table of this particular sort? Obviously because when a congressman sees a quotient like 35.85 after the name of a state like Pennsylvania, he naturally supposes that Pennsylvania is theoretically entitled to a voting strength of 35.85. It is only on this supposition that he feels that 36 is a fairer allotment than 35. But is this supposition justified? Do the quotients in such a table really represent the allotments to which the states would be entitled in a theoretically perfect apportionment? The answer obviously depends on the nature of the constant divisor by which these quotients are obtained. How is this "constant divisor" selected?

Here is the point where the name "major fractions" is thoroughly misleading. In the Vinton method, which was used on every occasion from 1850 to 1900, the "constant divisor" was obtained in the natural and obvious way, as the result of dividing the total population of the country by the total number of representatives, and therefore truly represented the average size of the congressional district. Under the Vinton method, the series of quotients obtained from the constant divisor did actually "sum up to 435" (or whatever the size of the House then was). Under these conditions the series of quotients did represent, in a simple sense, the true amount of representation to which the several states were theoretically entitled, and the fractions occurring in those quotients had a certain legitimate interest.

But this is not true in the method used in 1910. The Willcox divisor is not obtained by dividing the total population by the total number of representatives, and is not in any sense the standard size of a congressional district. The Willcox "quotients" are

totally unlike the quotients to which Congress was accustomed from 1850 to 1900, and have no relation to the exact amount of representation to which the states would be entitled in a theoretically perfect apportionment. The "whole series of quotients" does not sum up to 435.¹

The following example will illustrate the complicated and artificial character of the Willcox divisor. Twenty-two representatives are assigned to the six states A-F by the method of major fractions (MF). The true ratio of population per representative is 250,000. The exact quota obtained by dividing the population of any state by 250,000 shows the voting strength to which that state would be entitled in a theoretically perfect apportionment, and the series of exact quotas sums up, of course, to 22.

State	Population	(250,000) Exact quota	MF	(229,500) Artificial quotient
A	1,494,000	5.976	7	6.510
B	1,260,000	5.040	5	5.490
C	1,030,000	4.120	4	4.488
D	801,000	3.204	3	3.490
E	572,000	2.288	2	2.492
F	343,000	1.372	1	1.495
	5,500,000	22.000	22	23.965

The artificial divisor, 229,500, which yields the series of artificial quotients in the last column, is determined by a complicated process which Professor Willcox himself admitted, in 1911, is "somewhat difficult to explain." These artificial quotients sum up to nearly 24 instead of 22, and bear no relation to the true quotas. It will be observed that state A, whose theoretical voting strength is less than 6, actually receives 7 representatives under the method of major fractions. (If the Vinton method or the method of equal proportions had been used in this example, state A would have had 6 and state F would have had 2.)

¹ Professor Willcox's article in SCIENCE, February 8, 1929, p. 164, contains the following paragraph, which is likely to give the erroneous impression that "the whole series of quotients" would sum up to 435: "If the secretary of commerce is called upon, for example, in 1930 to apportion 435 members by the method of major fractions, he would probably send to Congress not merely a list showing the number of representatives allotted to each state, but with it a table showing the population of each state by the latest census divided by a constant divisor and one representative allotted for each unit and each fraction larger than one half in the series of quotients. The whole series would sum to 435." In SCIENCE for March 29, p. 357, however, Professor Willcox explains that this statement was ambiguous and that the "whole series" which would "sum to 435" was intended to refer not to the "series of quotients" but to the series of representatives. He agrees that the series of quotients does not sum to 435.

To attribute to the method of major fractions a simplicity which belongs only to an earlier process is a case of mistaken identity.

All these useless complications about "divisors" and "quotients" and "fractions" are completely done away with in the modern theory which provides a simple and direct test for the settlement of any dispute between two states. The whole story can be set down in a single paragraph as follows.

In theory, every state should be on a parity with every other state in the matter of apportionment. If in an actual case the congressional district in one state is, say, 10 per cent. larger than the congressional district in another state, then the "disparity" between the two states is said to be 10 per cent. *The method of equal proportions distributes the seats among the several states in such a way that any transfer of a seat from any state to any other state will be found to increase, rather than decrease, the disparity between the two states.* In other words, an apportionment made according to the method of equal proportions is one which can not be "improved" by any shift in the assignments.

This is a test which any one can apply to any given apportionment without any knowledge of the technical short-cut process by which the assignments may have been computed. (See the *Transactions of the American Mathematical Society* for January, 1928.) No "constant divisor" or "series of quotients" forms any part of the process.

The objection is sometimes raised that for purposes of measuring the disparity between two states the size of the congressional district is not so important, on constitutional grounds, as the "individual share" in a representative which each inhabitant possesses. This objection is not valid, however, because if the congressional district in one state is 10 per cent. larger than the congressional district in another state, then also the "individual share" in the second state will be 10 per cent. larger than the individual share in the first state, so that the disparity between the two states remains 10 per cent., whichever basis of measurement is adopted. No question of constitutional interpretation is here involved, because either of these two interpretations is satisfied by the method of equal proportions better than by any other method.

The choice of the wrong method may give incorrect representation to a large number of states. In 1920, six states would have been incorrectly represented if 435 members had been apportioned by the method of major fractions. In 1930, if the estimated populations prove to be in error by only 2 or 3 per cent., a case may arise in which 22 states would be incorrectly represented.

The report of the National Academy of Sciences confirms the earlier report of the advisory committee to the director of the census, which concluded that "the method of equal proportions, consistent as it is with the literal meaning of the words of the constitution, is logically superior to the method of major fractions." The purely political attempts which have been made to retain the obsolete method of major fractions in current legislation have proved to be a serious menace to the whole reapportionment movement.

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THE RATE OF WORK DONE BY A RICKSHA-COOLIE

A PECULIARITY of the Chinese street scene is a vehicle strange to Europeans, but used in East Asia, the ricksha. To the physiologist the man drawing the ricksha is especially interesting, for the ricksha-coolie is a man trained for one special movement only, fast locomotion.

Two kinds of running can be distinguished: (1) Relatively slow running with 100 double paces in one minute and with a length of step up to 210 cm. The foot is posed in the same manner as in walking. The sole touches the ground completely during a short time before pushing off with that foot. (2) The second kind of running, making possible a quicker locomotion, involves contact only between the toes and ball of the foot and the ground; but this kind of running can not be continued for any long time.

In the ricksha-coolie there is a rolling motion of the foot, which is both directly visible and demonstrable in photographs. It is characteristic of the first kind of running, and corresponds with the length of the step. In order to demonstrate this I marked off in a very busy street a measured distance, and from a window situated not very far from the street I counted the steps taken by ricksha-coolies in covering this distance. This method has the advantage that the observed person is not aware of being observed, and the length of step is that usually employed. Unlike laboratory experiments all movements are unconstrained and show no more than normal power. In my observations the double step was from 130 up to 200 cm long, depending upon the degree of fatigue. According to Weber a step of 210 cm length forms the border beyond which only the toes and ball of the foot touch the ground.

The number of paces in a minute varied between seventy-six and eighty-seven. The velocity of forward movement of the body was from 109 to 162 m in a minute, or from 6,600 to 9,700 m in an hour.

In ordinary running the arms are also moved, each in reverse direction from the homonymous leg. This movement is impossible or at least very limited in the ricksha-coolie, because he puts the forearms on the shafts; but as the ancient Greeks practiced running in an ambling pace, *i.e.*, right arm and right leg forward at the same time, it appears that the movement of running is not hindered by fixing the arms.

In estimating the work done in drawing the ricksha it must be remembered that the ricksha is so constructed that during motion the center of gravity is over the axle. Consequently the coolie need exert no force upwards, but can apply all his power for pulling. This traction on level ground need only overcome the resistance of friction. I have found this resistance to be from 2 to 5 kg for the occupied ricksha, according to the nature of the ground. These figures harmonize with other data for the frictional resistance.

The work done by the ricksha-coolie is consequently the same as if he were drawing a cord over a pulley at the end of which is fastened a weight of from 2 to 5 kg. In effect while traversing one kilometer he lifts a weight of from 2 to 5 kg to a height of a thousand meters and does a quantity of work of from 2,000 to 5,000 kgm. The work done in one minute is from 260 to 650 kgm.

Thus during fast locomotion about one tenth of a horse-power is used for drawing the ricksha. This is the expenditure of energy over and above that which would occur during running at the same pace without drawing the loaded ricksha. The period during which this high velocity can be maintained is only a few minutes at a time. Both the amount of external work per minute and the duration for which it can be maintained are therefore less than that of the Egyptians who lift water from the Nile,¹ while themselves standing still, or that of French navies² ascending a ladder. It is much less than that of the oarsmen in a university crew during a boat race.³ The energy which the coolie can apply to drawing the ricksha is limited by the considerable exertion involved in transporting his own body by running.

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¹ J. S. Haldane and Y. Henderson, "The Rate of Work Done with an Egyptian Shadouf." *Nature*, August 28, 1926.

² Jervis Smith, "Dynamometers." (Quoted by Haldane and Henderson (1).)

³ Y. Henderson and H. W. Haggard, "The Maximum of Human Power." *Am. Jour. of Physiology*, 72: 264, 1925.

CHEMICAL "TESTS"

EVERY profession, trade or branch of knowledge has its use of words and phrases which convey specific meaning which can be accurately and briefly conveyed in no other way. In chemistry the word "test" carries a very specific meaning. When a chemist "tests" a certain material for phosphorus, he wishes to determine if there is any of this element present and expects to obtain only a very general idea of the relative amount of the phosphorus present. He may not be able to say whether there is nearly 5 per cent. or nearly 20 per cent. present in the material "tested." He may "test" a substance to determine the presence or absence of potassium by a simple flame test requiring less than a minute of time. This "test" is *qualitative* and gives only a vague idea of the per cent. of potassium present. If a chemist wishes to determine the per cent. of potassium in a sample he uses an entirely different procedure requiring several hours of time. This latter procedure is not a "test" but is a *quantitative* determination of the amount of potassium present. The material is *analyzed* for potassium.

In research and other publications, in conversations with scientific men and in correspondence one often notices the word "test" used when reference is actually made to a method of analysis to determine quantitatively the amount of a certain element or compound present in a substance. One may incorrectly mention a protein "test" when he actually has reference to a procedure (Kjeldahl method) which will determine the quantity or per cent. of protein (N) present. A test for the presence or absence of protein may be made by simpler methods (Biuret, etc.). Most requests which come to a chemist are actually for an *analysis* of a sample (for protein, for instance) and not for a "test" (for protein). He *analyzes* the sample and makes a determination of the *per cent.* of protein. He does not "test" the sample for protein or run a protein "test."

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ATMOSPHERIC ELECTRICITY DURING SAND STORMS

THE Jornada Range Reserve—near Las Cruces, New Mexico—is an experiment station maintained by the U. S. Forest Service for the purpose of the study of range problems. Since grazing studies are paramount, the station laboratory is not equipped with the instruments used in the measurement of electrical energy. However, the article entitled "Electricity from the Air" which appeared in the News Supplement of *SCIENCE* of March 30, 1928, brings

to mind some very interesting observations which were made recently at the Jornada headquarters.

Numerous stories regarding the electrical phenomena which occur during sand storms are in circulation throughout this region. These accounts vary with the personal characteristics of the story-teller. Some versions are no more than drab, conservative statements. Others are displayed in a glamorous setting of colorful phrases and artistic profanity. All of them deal with a near electrocution of some luckless cowboy while placing the coffee pot on the camp stove during a sand storm, or with automobiles becalmed by static under similar climatic conditions.

The first tangible indications of proof observed by the writer that these accounts were not without foundation were obtained during a severe storm on April 4, 1928. On the afternoon of this day the sand storm reached its peak of violence between three and four o'clock in the afternoon. During this time the sky was cloudless. The first evidence of an electrical disturbance was observed in the vacuum tube lightning arrester on the office telephone. Between the carbons of this device, a strong electric arc would form and continue uninterrupted for a period of about thirty seconds. When the arc was broken it was immediately followed by another arc of the same general character.

The radio receiving set was the second object of concern. This instrument is equipped with a 75-foot multi-strand copper aerial which is elevated about twenty feet above the ground. Both the aerial and the telephone wires extend in a north and south direction, which places them at right angles to the strong west wind.

The receiving set was disconnected from the ground and aerial. The tip of the lead-in wire from the radio antenna was placed near the tip of the ground wire. An electric arc resulted immediately. By varying the distance between the wires it was found that three and one half centimeters was the maximum width of the gap over which an arc would form. With this arrangement of the wires, the arc was consistent and would continue for a period of thirty seconds without a visible break. The breaks were of short duration when they did occur. The path of the arc varied in its course, between the ground and antenna tips, much after the manner of chain lightning.

Subsequent observations made during the night revealed a much longer arc of about four and one half centimeters in length. This longer arc was of a filmy nature which made a glow rather than a light, as did the arc when the wires were closer together.

When the storm was strongest a spark would span the gap at about seven centimeters. Sparks jumped

this gap at the rate of about one per second. As the storm lessened in violence the rate of spark formation slowed down and became erratic. The width of the gap which the spark would jump decreased rapidly as the storm abated.

The presence of so great an amount of electricity in the air may be the reason for the conspicuous unrest of men and live stock during sand storms. This condition is usually attributed to the discomfort caused by the wind and sand. However, the wind and sand do not account for the fact that the same feeling of unrest is, in a lesser degree, experienced by a person who is sheltered within a thick-walled, adobe house.

R. H. CANFIELD

JORNADA RANGE RESERVE

SCIENTIFIC BOOKS

Life and Work of Sir Norman Lockyer. By T. MARY LOCKYER and WINIFRED L. LOCKYER, with the assistance of PROFESSOR H. DINGLE. Macmillan and Company, London. 1928. xii+474 pages.

As the title indicates, this book is divided into two parts, of which the first contains the general biography of Sir Norman Lockyer. These chapters are filled with many details about the events in the long life of this great pioneer in the field of astrophysics. Such a story can not fail to be entertaining reading for all who are interested in the development of modern science, because Lockyer's own scientific interests were wide, and he gave much attention throughout his life to all sorts of things connected with the advance of science in general.

He wrote no end of articles, and gave innumerable lectures before all kinds of audiences for the purpose of bringing scientific knowledge and facts to the attention of the whole English nation. With this end in view, in 1869 Lockyer started the general scientific magazine *Nature*, and was its editor for fifty years. During these years it achieved great success, due to his untiring efforts and the willingness of the publishers, Macmillan and Co., to wait patiently for the magazine to become a financial asset.

The activity of Lockyer during his entire career is amazing. As a young man, he did his astronomical work in his spare hours, and earned his living as a clerk in the War Office. It was while he was thus employed that he developed and put to the test of observation the method of using the spectroscope to view the solar prominences, which up to that time had been seen only during total eclipses. This discovery alone would have established his fame as an astronomer for all time. Toward the end of his life, he was greatly

disappointed by the transfer to the University of Cambridge of the Solar Physics Observatory of which he had been director for so many years. Although he was then seventy-five years old, he went energetically to work and with the help of friends founded a new observatory at Sidmouth, which he directed until his death seven years later. It is now known as the Norman Lockyer Observatory.

Lockyer seems to have been always ready to add one more to his list of activities. It is easy to believe the remark quoted from him: "The more one has to do, the more one does." The enumeration of the great number of lectures he gave and of the numerous gatherings he attended becomes rather overwhelming, especially in the chapters dealing with the later part of his life. The reader would be more impressed by the really important events if fewer details of the lesser happenings had been included.

The second part of the books consists of thirteen chapters dealing with various phases of Lockyer's scientific work. With the exception of one chapter, containing an address given by Lockyer, these chapters were written by well-known scientific men who are qualified to judge of the importance of Lockyer's contributions to science. They give the reader a very clear idea of the relation of his work to modern investigations. It is impressive to see "how much the recent progress in astrophysics runs on the lines initiated by Lockyer."

The chapter in which is reprinted one of Lockyer's addresses tells the story of helium. It is most interesting to read in Lockyer's own words this story from the time in 1868 when he observed in the solar spectrum "the yellow line near D" until the time twenty-six years later when the line was produced in the laboratory. During all those years, Lockyer persevered in his belief that this line was due to a new element, although he was almost alone in this opinion. In the end his theory was vindicated, as happened in other cases where he felt that the observed facts required explanations opposed to the ideas then generally accepted. Another such example is his theory about the evolution of the stars. He held that in the course of a star's evolution the temperature first rose and then fell, instead of decreasing from the very beginning of the star's life as other astronomers thought at that time. The theories of to-day agree in general with Lockyer's idea.

The last chapter gives some personal recollections of Lockyer by Professor A. Fowler, who was Lockyer's assistant in the laboratory for many years and who succeeded him when he retired from his post as professor at the Royal College of Science. In this chapter, better than anywhere else in the book, there is presented a real picture of the forceful and versatile personality of this most enthusiastic scientific worker.

All who read these pages will surely hope with Professor Fowler "that means may be found to perpetuate his memory by the provision of funds to place the observatory (at Sidmouth) on a permanent basis."

IDA BARNEY

YALE UNIVERSITY OBSERVATORY

Lebenslinien. Eine Selbstbiographie. Von WILHELM OSTWALD, Berlin: Klassing & Co. 3 volumes.

OSTWALD has written his autobiography, and every chemist will want to read it because in it we find the reactions and the reflections of a man who took an active part in building up a branch of the science. His early struggles in Riga and in Dorpat as an unwilling subject of the Russian empire; his Leipzig tenure and the subsequent development of a great school of physical chemistry under his leadership; his championship of Arrhenius and van't Hoff; his writings, and to a less extent, his researches; his disputes with colleagues in and out of the university, and his final retirement to private life to devote his remaining energies to art and to philosophy are all vividly described, as one would expect from the pen of one of the foremost writers on science.

Ostwald is refreshingly frank in expressing his thoughts. One feels that no restraining hand was at work when he sat down to say what he had to say about the men with whom he came in contact. And yet, one would be apt to close the book with more liking for the man if there were some self-criticism interspersed between the pages of his three volumes. One is left with the general impression that many men wronged him; one nevertheless carries away the impression that he was not always in the right, if only because of his repeated assurances that the others were the wrong-doers. One also carries away a very distinct impression that everything was measured with a mental meter-rule planned and perfected by Germans who, in turn, were impregnated with the germ "Deutschland über alles." His somewhat caustic comments on American universities and university men and on America itself seem not so much the result of objective criticism as of nationalistic self-conceit. Even his bitter comments on the attitude of Ramsay and others towards German science—an attitude resulting from the late war and, as we realize to-day, a highly unjustified one—awaken but little sympathy, because he himself has such little sympathy for things other than German.

I may be somewhat unjust to Professor Ostwald, but such is the general impression the book leaves me with. Nevertheless, as a scientist, and, more particularly, as an "organizer" of science, Ostwald will go down in chemical history with the group of immortals.

BENJAMIN HARROW

SOCIETIES AND ACADEMIES

THE AMERICAN SOCIETY OF
MAMMALOGISTS

THE eleventh annual meeting of the American Society of Mammalogists was held at the Museum of Zoology, University of Michigan, Ann Arbor, Michigan, from April 9 to 13, 1929, with approximately sixty members, besides many visitors, in attendance. During the three days that were devoted to the presentation of papers there were thirty-eight items presented, including lectures and moving pictures.

During the evening of April 10 the Museum of Zoology tendered the society, together with members of the Society of Ichthyologists and Herpetologists, a reception, preceded by an inspection of the museum, its collections and exhibits. The morning of April 11 was devoted to a program of mammalian genetics arranged by Dr. Clarence C. Little, and in the afternoon, one on mammalian parasitology under the direction of Professor G. R. La Rue. During the evening members and their guests attended the annual dinner of the society, the speaker of the evening being the retiring president, Dr. Glover M. Allen.

The program of papers was concluded the evening of April 12 by an illustrated lecture entitled "A Cross-section through the Sudan," by H. E. Anthony, and the following morning was devoted to a tour of the university.

At the directors' and business meeting the following officers of the society were elected for the ensuing year: *President*, Witmer Stone; *vice-presidents*, T. S. Palmer and M. W. Lyon, Jr.; *recording secretary*, H. H. Lane; *corresponding secretary*, A. Brazier Howell; *treasurer*, A. J. Poole, and *editor*, H. H. T. Jackson.

Formal announcement was for the first time made of the completion of the fund that has been raised in commemoration of Joel Asaph Allen. This fund of ten thousand dollars was raised through the able efforts of a committee consisting of Madison Grant, *chairman*, Henry Fairfield Osborn, Childs Frick, George Bird Grinnell and Harold E. Anthony. At this meeting the fund was officially entrusted to the society and a rising vote of thanks was tendered to the committee in token of its successful efforts. The sum will be added to other invested funds of the society and the interest used to defray the expenses of publishing one number per year of the *Journal of Mammalogy* to be designated as the Allen Memorial Number.

The meeting for 1930 will be held, probably during April, at the American Museum of Natural History, New York City.

A. BRAZIER HOWELL,
Corresponding Secretary

SCIENTIFIC APPARATUS AND
LABORATORY METHODS

A SIMPLIFIED DIGITAL SPHYGMOGRAPH

MANY mechanical devices have been adapted to the recording of the pulse, and some of these have yielded excellent results in the hands of experienced workers. However, when elementary students are confronted with the task of securing records from instruments requiring skilful manipulation and adjustments the efforts are not always encouraging. Even students in advanced classes experience some difficulty when the Dudgeon type sphygmograph is placed in their hands. The Tambour type is perhaps involved in less delicate adjustments but because of extrinsic factors is not all that might be wished. For some years the writer has been using a comparatively simple device which has yielded excellent results and because of its ease of assemblage and its freedom from delicate adjustments is suited to student use generally. In principle it revives the old digital sphygmograph designed by Laularie which was put upon the market in France by Verdin. The chief virtues of the apparatus here described are that it is "foolproof," is easy to assemble, and is inexpensive since it appropriates the Harvard pieces found at hand in most laboratories.

A glance at the accompanying figures will disclose the essential mechanical principles of two levers in series mounted upon typical Harvard adjustable iron

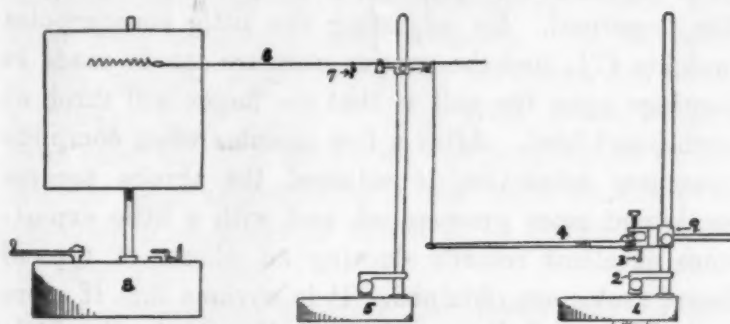


FIG. 1. Detail Assemblage of Digital Sphygmograph.

- | | |
|-----------------------|-----------------------|
| 1 Adjustable Stand | 6 Heart Lever Arm |
| 2 Adjusting Screw Arm | 7 Shot Counterpoise |
| 3 Nail Pad | 8 Harvard Kymograph |
| 4 Muscle Lever Arm | 9 and 10 Double Clamp |
| 5 Adjustable Stand | |

stands. On stand (1) is a Harvard light muscle lever, with a small piece of No. 14 copper wire looped and soldered to the lever in such a way as to protrude backward and downward below the fulcrum to constitute the nail pad (3). The long lever arm (4) will be recognized as the usual light aluminum writing point which mounted edgewise gives stiffness for the silk thread attachment at its extreme end. A light heart lever of Harvard type is mounted on the second standard (5), with its long aluminum rod supporting a writing point. The silk thread spans the space and connects the long arm of one lever with the short arm of the other, and by adjustment the appropriate

amplification of the writing point is effected. After some experimenting two little BB shot split and mounted on silk thread in the usual way (7) were found effective counterpoises. These are held after adjustment by a smear of colophonium wax placed over the loop.

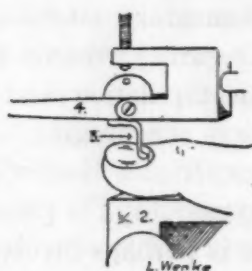


FIG. 2. Finger Placement and Dispatching Lever.

- 2 Adjusting arm for finger support
- 3 Nail Pad
- 4 Lever Arm

Preliminary to taking records the student acting as subject is seated at the laboratory table in such a position that the right forearm rests comfortably upon the table. The ball of the finger (preferably the index finger although any finger will serve) is slipped up on the adjusting screw arm (2), the thumb then rests comfortably on the base of the stand and the other three fingers are flexed and rest naturally upon the table under the palm. The double clamp (9) carrying the dispatching lever (4) can then be lowered so that nail pad (3) will press gently upon the fingernail. By adjusting the little counterpoise weights (7), just the proper pressure can be made to impinge upon the nail so that the finger will throb at each heart beat. After a few minutes when complete muscular relaxation is attained the throbs become more and more pronounced, and with a little experience excellent records showing all phases of typical heart cycles are obtained. It is obvious that if more weight is needed to accentuate the throb, the little lead weights should be moved outwards on the lever arm (6). It is also clear that if the throb in the

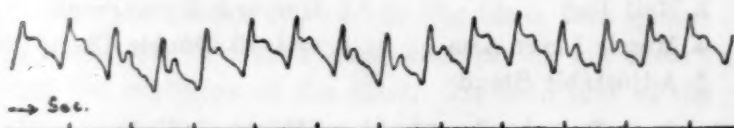


FIG. 3. Typical Sphygmogram.

Note the sharp amplitude, well-defined dicrotic notch with pre- and post-dicrotic phases in most instances.

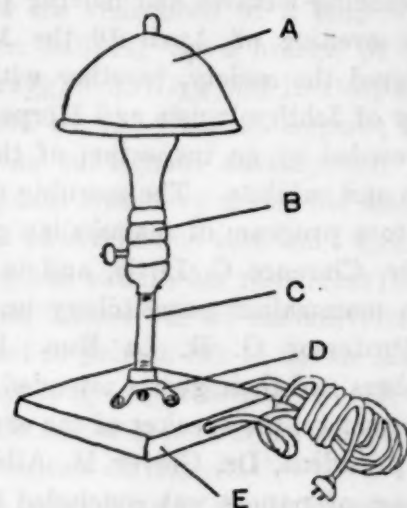
finger needs to be amplified it is only necessary to reduce the length of the short arm of the writing lever by slipping the silk thread nearer the fulcrum at (10). By making these adjustments it has been possible to obtain excellent records of considerable amplitude on the smoked kymograph drum (8).

FRANCIS MARSH BALDWIN

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AN ECONOMICAL LABORATORY TABLE LIGHT

A VERY satisfactory table lamp for microscopic work in elementary courses in biology may be made at a small fraction of the cost of such lamps as sold by the regular dealers. The materials, with the exception of the brass shade, may be bought in any hardware store, and may be assembled in half an hour by a janitor or student assistant. The appearance of the finished product, as shown in the figure, is quite good.



The base, *E*, is a wooden block about 6x6x1 inches in size, with a one-inch hole through the exact center, under the column of the lamp, a quarter-inch hole running from the center of one edge of the base to the central hole; this makes it easy to run the flexible cord, which may be of any desired length, to the base of the socket, *B*. The switch-socket is screwed to the end of a 3 x 5/8 inch gas-pipe "nipple," *C*, which, in turn, is attached to the base, directly over the central hole, by what the electricians call a "crow-foot," *D*, used by them to attach hanging lights to ceilings.

An ordinary inside-ground bulb gives very satisfactory results, though a "daylight" glass bulb would, of course, be better.

The brass shade, *A*, keeps the light out of the student's eyes. The base and iron-work may be painted with black enamel paint or finished in any way desired.

The cost of the outfit is about as follows: brass shade, .45; nipple, .05; crow-foot, .05; switch-socket, .20; 8 ft. flexible cord, .20; plug, .05; base and paint, .05; total, \$1.05, not including bulb.

This type of lamp has an advantage over the usual type of microscope lamp in that it not only illuminates the microscopic object but also gives a good light upon the student's note-book. It is light and compact and is easily removed from the table when not needed.

A. M. REESE

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SPECIAL ARTICLES

PHOTOIONIZATION OF CAESIUM VAPOR¹

SERIOUS discrepancies between the results of different observers on the continuous absorption and photoionization of alkali vapors have indicated the desirability of repeating the photoionization experiments. Mohler, Foote and Chenault² have published measurements of the relative photoelectric sensitivity of caesium vapor using the effect of positive ions on a negative space to detect ionization. Later, Little³ made direct measurements of the photoionization. There is fair agreement as to the form of the sensitivity curve but Little's absolute value of the atomic absorption coefficient, 2.2×10^{-21} , is surprisingly low.

The atomic absorption coefficient $k(\nu)$ at a frequency ν , derived by equating the number of quanta absorbed to the number of ions produced, is:

$$k(\nu) = I\nu/eNpl J(\nu)$$

where I/e is the number of ions, $J(\nu)/h\nu$ the number of quanta incident, Np the number of atoms per cc and l the length of the ionization chamber.

The ionization chamber was designed to reduce to a minimum the surface photoelectric effect of the radiation. The anode was a cylinder 8 cm long and 3 cm in diameter with holes 1 cm in diameter in each end. The cathode was a strip 1 cm wide, and nearly as long as the cylinder, placed a few millimeters from the side of the cylinder. This served as the receiving plate and was protected by guard rings from surface leakage. The containing tube was quartz with a flat window at one end and a horn-shaped light trap at the other end. The body of the tube was held at about 220° C. while an appendix containing the caesium was kept at some lower temperature by a separate electric heater.

The beam of light from a circular diaphragm in front of a mercury arc (110 volt uviarc) focused by a quartz fluorite achromat was small enough to pass through the holes in the anode cylinder without striking them. The image just filled the receiving surface of a disk thermopile which could be placed at the position of the ionization chamber. The thermopile calibration was determined under operating conditions by means of a radiation standard.⁴

Since the sensitivity curve of caesium is known it was not essential to use monochromatic radiation provided the spectral energy distribution was known. This was measured with a Bausch and Lomb monochromator and a linear thermopile. Comparison of the photoionization and the radiation flux was based on the effect of radiation from the mercury arc passed

through a water cell and Corning purple glass G986 A. The caesium sensitivity has a maximum at the limit 3184 Å and drops rapidly to about 15 per cent. of this value at 2700 Å. Mercury lines on the red side of 3130 Å give no ionization while 3130 has by far the greatest effect of all the lines. The purple glass transmits mercury lines from 4047 to 2967 Å, while a filter of the purple glass and ordinary window glass cuts out 3130 and all lines of shorter wavelength. The addition of window glass to the filter reduces the photoionization to zero and the thermopile readings to about 50 per cent. of the effect with purple glass alone. It was found that about 31 per cent. of the arc radiation transmitted by the purple glass was 3130 while 78 per cent. of the photoionization came from 3130. On the basis of these data and corrections for absorption in quartz windows, k for 3130 has been computed from measurements of the ion current at caesium pressures ranging from .005 to .06 mm (146 to 201° C.). Pressures were computed from an equation based on data by Kroner:⁵

$$\log p = -3966/T + 7.165$$

The currents were proportional to the pressure within experimental error and gave a mean value of k (3130) $= 1.85 \times 10^{-19}$. This proportionality and the absence of any effect with lines on the red side of 3130 confirm the absence of any surface effect. Measurements with radiation resolved by a monochromator check this value with somewhat lower precision. On the basis of the spectral sensitivity curve we derive the value $k(3184) = 2.3 \pm .2 \times 10^{-19}$. The error comes largely from uncertainty in measuring the temperature of the caesium while uncertainties in the vapor tension data introduce a considerably larger error not included in the estimated error.

The discrepancy between our result and Little's value ($k(3130) = 2.2 \times 10^{-21}$) is not understood. Experimental magnitudes were about the same in his work as in ours except as concerns the observed ion current, which was about fifty times as large in our experiment. Little's methods were in many respects more accurate than ours but various check experiments seem to rule out the possibility of any serious error in magnitude in our result. An insufficient amount of caesium or a trace of oxidation from a slight air leak can give rise to abnormally low values of vapor density and of k .

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⁵ Rowe, *Phil. Mag.*, 3: 354, 1927.

¹ Publication approved by the director of the Bureau of Standards of the U. S. Department of Commerce.

² *Phys. Rev.*, 27: 37, 1926.

³ *Phys. Rev.*, 30: 109, 1927, and correction note, p. 963.

⁴ Coblenz, *Bull. Bureau Standards*, 11: 87, 1914.

HEMOGLOBIN MAINTENANCE UPON SYNTHETIC DIETS

THE point of view, developed mainly by Whipple and Robscheit-Robbins,¹ that certain foodstuffs possess special virtues as curative agents in experimental secondary anemia has been generally accepted. Indeed, anemias of various types have come to be regarded (perhaps uncritically) as problems in nutrition. It seemed pertinent to inquire whether a synthetic diet, which has been shown to maintain experimental animals in apparent health, is also a maintenance diet in respect to hemoglobin. Such a diet, composed in large part of purified food materials, is the Karr-Cowgill² ration for dogs. Will dogs, fed exclusively upon this diet over long periods of time, maintain hemoglobin at a "normal" level?

Five dogs, fed upon the Karr-Cowgill diet for periods of from six to eighteen months, maintained their hemoglobin at fairly constant normal levels from week to week. During the course of this work there were published the very interesting papers of Hart and his associates³ upon the importance of salts of copper in the cure of severe anemia in rats due to an exclusive milk diet. Although it is not wise to assume that experiments upon one species apply to another, it seemed very desirable to determine the copper content of our synthetic ration. Copper was determined by the potassium ethyl xanthate method,⁴ which was checked as to accuracy by analysis for small amounts of added copper. The results of these analyses served to modify the course and, indeed, the original purpose of our investigation.

Sixteen grams (the quantity fed per kilogram body weight) of the Karr-Cowgill diet was found to contain 0.052 mgm of copper. In the experiments of the Wisconsin investigators, 35 cc of milk consumed by a rat per day contained 0.01 mgm of copper. For a 50-gram rat this represented 0.2 mgm copper per kilogram body weight. Therefore, in respect to the ingestion per kilogram of body weight, the amount of copper in the diet fed to our dogs was approximately one fourth that supplied to Hart's rats on the whole milk (anemia-producing) ration. The hemoglobin maintenance levels of our dogs and the speed

of recovery after single large bleedings were not influenced by the addition of CuSO_4 to the diet, raising the level of copper fed daily to 1.3 mgm per kilogram of body weight. The method of feeding the ration to which copper had been added was slightly modified to avoid the possibility of incompatibility between CuSO_4 and KI in our salt ration (*i.e.*, formation of insoluble CuI). Furthermore, analysis of the excreta for copper indicated that most of the copper administered was retained by the animal.

It was of interest to determine the source of the copper in our original diet. Surprisingly, analysis of the individual salts in the "salt mixture" proved negative, while the copper content of the commercial casein (the protein component of the diet) and Vitavose (used as the source of vitamin B) accounted for the total copper. Modifying the Karr-Cowgill diet by using coagulated egg albumin as the protein and Harris yeast concentrate and dry brewers' yeast as the sources of water-soluble vitamins and with other slight changes, we constructed a "copper-free" synthetic diet suitable for rat-feeding experiments. By the addition of CuSO_4 to this diet, we had two similar synthetic rations complete in all known dietary essentials and differing only in the presence of copper. When fed *ad libitum* approximately 10 g of synthetic diet were consumed per rat per day. In several analyses of 10 to 20 g samples of diet by the xanthate method, which is sensitive to 0.01 mgm, no copper was found in the ration designated as copper-free. The small quantity of copper added to the copper-free ration in making up the copper-containing diet was quantitatively checked by the xanthate method.

Most of the rats used were of a "skin-parasite free" strain. They were kept in a special room in individual cages. The possibility of copper contamination of the rats upon the copper-free ration was eliminated. The animals were placed upon the special diets at the age of twenty to twenty-four days. The growth, general appearance and hemoglobin maintenance were normal in the rats on the copper-containing and also in those on the copper-free diet. Five rats upon a whole milk diet developed a severe anemia. This anemia was promptly cured by placing these rats upon the copper-free synthetic ration. It should be mentioned that diarrhea invariably accompanied milk feeding and in two of the milk rats growth, which had been retarded, was promptly resumed on the copper-free diet.

Further experiments are in progress.

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